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Using fire hose to protect microclimate station electrical cables in forest research

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Rationale

Understanding the effects of silvicultural activities on forest vegetation ecophysiology and ecosystem processes is critical to continued development and improvement of ecologically sustainable forest management practices. As a result, applied forest research has become increasingly integrated in approach, with multi-disciplinary teams working together to examine forest ecosystem responses to management practices at multiple scales. Short- to long-term monitoring of spatial and temporal changes in micrometerological variables associated with silvicultural treatments (Arnott et al. 1995, McInnis and Roberts 1995, Carlson and Groot 1997, Chen et al. 1999) or natural disturbances (Bazzaz and Wayne 1994, Lautenschlager and Nielsen 1999) are an increasingly common component of this research. As well, basic research on forest ecosystem processes (e.g., biogeochemical cycling) typically includes micrometeorological measurement as a fundamental part of the experimental approach (Fernandez et al. 1995, Sellers et al. 1995).

Microclimate is typically measured using dataloggers and environmental sensors programmed to measure radiation, wind speed, precipitation, air temperature, humidity, soil temperature, and soil moisture at various time intervals and locations. The installation and regular maintenance of microclimatic stations is costly, particularly for field trials established over large, remote areas. Damage to station components by weather, wildlife, and/or humans is problematic, and must be minimized to collect complete, high quality data sets. We have experienced frequent damage to insulated electrical cables connecting the sensor body to the datalogger by small mammals that chew exposed cable lengths. This results in loss of data and the need to replace sensors, as cables are not easily repaired.

Protecting cables from this and other types of mechanical damage may be avoided by burial beneath the soil surface. However, this approach is labour intensive and may be too disruptive to the site to be a viable option for some applications. In areas with exposed bedrock, cable must be covered with logging slash or downed woody debris to minimize exposure to animals. Identifying the location of these underground cables with flagging or pins is also necessary in the event sensors need to replaced, or to avoid damage during soil sampling or seedling excavation. To overcome this problem, cables may be suspended aboveground, but this restricts the movement of larger wildlife species and field crews operating on site. Unfortunately, for field trials located in areas of high public use, equipment within plain view along travel corridors may also be vandalized or stolen.

Here we provide information about a cost effective, efficient method of protecting microclimate electrical cables used in forest research studies from damage. The advantages, materials and methods, and observed productivity differences using this approach are discussed in the hopes that it may be useful to others involved with microenvironmental monitoring systems.

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Advantages

Over the past few years, we have experimented with the use of fire hose to enclose cables and minimize mechanical damage. The hose can be slit open lengthwise and cables secured within or, for short cable lengths, the cable can be guided through intact hose using a stiff wire. This approach to protect cables dramatically reduces the time required to install and remove dataloggers and sensors and minimizes site disturbance. In addition, it is comparatively easy to replace defective or damaged sensors that are enclosed in fire hose. This approach has a number of other benefits in the field:

- The flexibility and light weight of fire hose allows it to be easily run over/under obstacles (e.g., downed branches, trees)
- Damage to cables and belowground sensors is minimized during tree planting, soil sampling, etc. because they are visible
- The entire length of cable can be secured, protecting wires from the sensor head to the entry port in the datalogger enclosure
- Hose is collapsible and can be rolled into small diameter coils for easy storage and transport (35- to 40-cm diameter coils for 30-m length)
- Cables are much cleaner when removed from the site and easier to inspect for physical damage

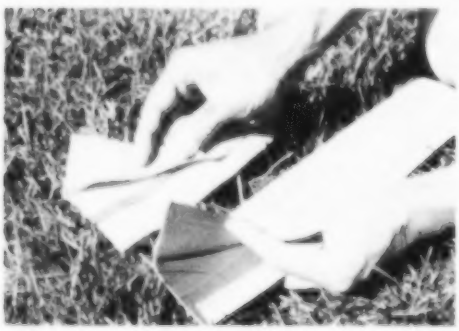

Figure 1. Unlined (top) and lined (bottom) fire hose.

Figure 2. Fitting insulated electrical cables into cut fire hose.

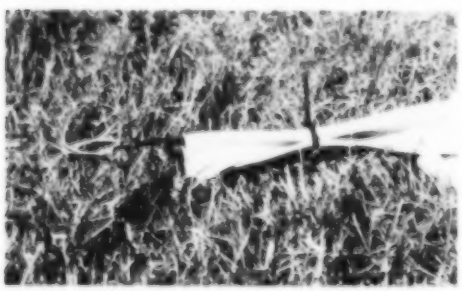

Figure 3. Cables enclosed in cut fire hose secured with plastic twist tie.

Materials and Methods

Types of fire hose

Hose used in forest fire activities is designed for strength and resistance to abrasion and high temperature damage. It is also lightweight with a 30-m length weighing between 3.5 and 5.5 kg. The hose collapses when not in use and can be rolled into coils for storage and transport. There are many types of fire hose available, differing in construction and physical attributes. We have used several types of single jacket fire hose, consisting of a thermoplastic or synthetic rubber lining covered with a tightly woven single layer, or jacket, of polyester, cotton-polyester blend, or synthetic yarn[1] (Figure 1). The most common fire hose we use is 3.8-cm internal diameter and varies in thickness from 0.25 to 0.80 mm depending on the type of lining. The hose lining also determines how easily and quickly it can be cut, and how easily cables can be guided through short lengths of intact hose.

We acquired single-layer fire hose from Aviation and Forest Fire Management Branch of the Ontario Ministry of Natural Resources. This hose was previously used in fire protection and prescribed burning activities but was damaged to the degree that it would usually be disposed of. This "cull hose" was obtained at no cost and recycled for use in our microclimate monitoring stations.

Preparing and installing hose

The hose can be used in either of two ways, depending on the application:

- slit open (cable lengths more than 8 m) or
- intact (cable lengths less than 8 m)

Where long cables are necessary, slit the hose near the natural fold of the longitudinal axis using a sharp utility knife or heavy duty hand shears. In our experience, 90 to 100 m of lined hose can be unrolled, cut, and rerolled per hour.

In the field, cut the fire hose to desired length based on where cables are going to be run. Tuck cables into the fire hose (Figure 2) from

[1] Unlined hose is not recommended since it deteriorates in the field and thus does not afford the longer-term protection of lined hose.

the sensor location to the inlet pipe located at the base of the datalogger enclosure. Cable(s) can be secured in the hose with 17-cm locking nursery ties (Cfrensch Ltd., Beamsville, ON) or similar material wrapped around the hose at 1- to 2-m intervals (Figure 3). Where possible, position several sensors along the same path to store several cables in a single length of hose. To secure hose to the forest floor, bend 30-cm lengths of stiff wire (e.g., ground cover staples, 11-gauge (3-mm diameter) steel wire; Canadian Forestry Equipment, Mississauga, ON) into a U-shape and push over the hose into the ground.

Alternatively, when short cables are sufficient, cut the fire hose to length and feed cables through the intact hose using an electrician's fish tape. Features of a typical weather station installation using fire hose are pictured in Figures 4-6.

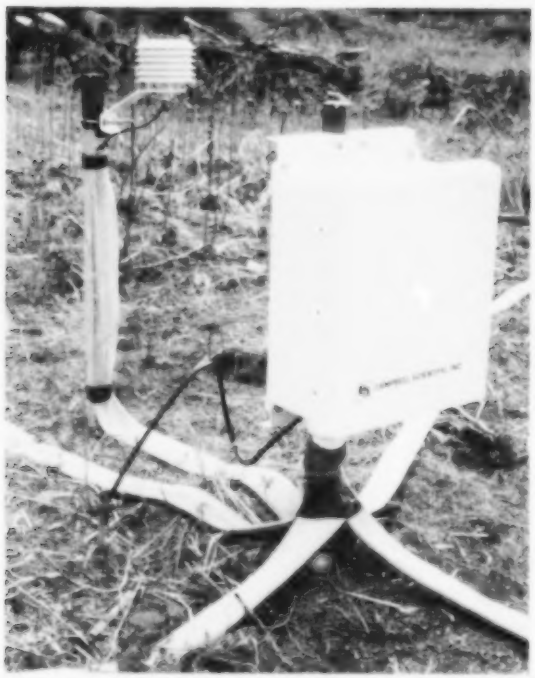

Figure 4. Data logger and air temperature/humidity sensor (background) showing fire hose used to protect cables. Note that hose covers entire cable length from sensor to entry port in data logger enclosure.

Figure 5. Length of cut fire hose wrapped with twist ties to secure cables.

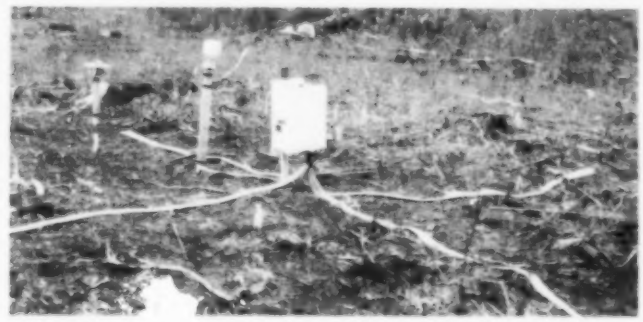

Figure 6. Data logger and environmental sensors with fire hose in a typical microclimate station application.

Comparative Case Study

This comparative case study is provided as an indication of potential time savings in the field using our fire hose method versus the traditional burying method on an actual field study.

A major ice storm in January 1998 caused extensive damage to forests in eastern Canada and the northeastern United States. In 1999, a large, cooperative, multidisciplinary research effort was undertaken in Ontario to determine the effects of this natural disturbance on the health and recovery of forest ecosystems (Lautenschlager and Nielsen 1999). Research to determine the influence of canopy damage and remedial treatments on maple syrup production included assessment of understory microclimate (Lautenschlager and Nielsen 2000). In spring 1999, microclimate stations were installed in the understory of 9 of 38 ice storm-damaged sugar maple stands. A 1-ha (100 m x 100 m) plot, which was further subdivided into 4, 0.25 ha subplots for understory treatments, was established in each stand. In each subplot, soil temperature and soil moisture were monitored at 5-cm depth in the mineral soil in 2 locations, 31 and 46 m from plot centre. Air temperature and humidity were measured at 15 m from plot centre in 1 subplot, and light intensity (photosynthetic photon flux density) was measured at 15 and 46 m from plot centre in 2 of the 4 subplots. A rain gauge was installed in each stand at 8 m from plot centre. Data were collected from April to October, after which dataloggers and aboveground sensors were removed to avoid winter damage.

For this installation, a total of about 670 m of cable was used per stand. By positioning aboveground sensors along the same path as soil sensors, about 185 m of cable needed to be buried to a depth of 5 to 10 cm. We made a slit in the soil with a shovel and slid cable bundles into this thin trench. In areas of exposed bedrock, we covered the cables with rotting logs or rocks. In most stands, this was arduous work due to the presence of secondary roots of large sugar maple trees or shallow, rocky soils. In each stand, installation required about 12 person hours, roughly half of which was devoted to burying or covering cables.

In spring 2000, microclimate stations with similar components and sampling design were installed in 3 additional stands. As well, aboveground sensors removed in fall of 1999 from 9 stands were reinstalled and damaged belowground sensors replaced. We used cut fire hose to protect the cables (Figure 6). This approach reduced installation time in the new stands to 8 person hours, roughly 25% less than required for burial. As well, reinstallation and replacement of sensors in the existing stands were accomplished in a fraction of the time.

Acknowledgements

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Literature Cited

Arnott, J.T., W.J. Beese, A.K. Mitchell and J. Peterson. 1995. Montane Alternative Silvicultural Systems (MASS). For. Can. and B.C. Min. For., Victoria, BC. FRDA Rep. No. 238. 3122 p.

Aussenac, G. 2000. Interactions between forest stands and microclimate: Ecophysiological aspects and consequences of silviculture. Ann. For. Sci. 57: 287-301.

Bazzaz, F.A. and P.M. Wayne. 1994. Coping with environmental heterogeneity: The physiological ecology of tree seedling regeneration across the gap-understory continuum. Pp. 349-390 *in* M.M. Caldwell and R.W. Pearcy (eds.), Exploitation of Environmental Heterogeneity by Plants. Academic Press, San Diego, CA. 429 p.

Carlson, D.W. and A. Groot. 1997. Microclimate of clear-cut, forest interior, and small openings in trembling aspen forest. Agric. For. Meteor. 87: 313-329.

Chen, J., S.C. Saunders, T.R. Crow, R.J. Naiman, K.D. Brosofske, G.D. Mroz, B.L. Brookshire and J. Franklin. 1999. Microclimate in forest ecosystem and landscape ecology. Bioscience 49: 288-297.

Fernandez, I.J., L.E. Rustad, J.A. Simmons and J.W. McLaughlin. 1995. The Howland Integrated Forest Study (HIFS) – Ecosystem research on processes governing forest function. Pp. 298-306 *in* A. Jenkins, R.C. Ferrier, and C. Kirby (eds.) Ecosystem Manipulation Experiments: Scientific Approaches, Experimental Design, and Relevant Results. Ecosystems Research Report No. 20, Office for Official Publications of the European Communities, Luxembourg. 374 p.

McInnis, B.G. and M.R. Roberts. 1995. Seedling microenvironment in full-tree and tree-length logging slash. Can. J. For. Res. 25: 128-136.

Lautenschlager, R.A. and C. Neilsen 2001 Ontario's forest science efforts following the 1998 ice storm. For. Chron. 75: 633-641.

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocci, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodson, P. Crill, K.J. Ranson, D. Lettenmaier, D.E. Wickland. 1995. The Boreal Ecosystem-Atmosphere Study (BOREAS): An overview and early results from the 1994 field year. Bull. Am. Meteorol. Soc. 76: 1549-1577.

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